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UNIVERSITY OF CALIFORNIA PUBLICATIONS.

COLLEGE OF AGRICULTURE.

AGRICULTURAL EXPERIMENT STATION.

IMPERIAL BUREAU OF MYCOLOGY
13 JUL. 1921

REPORT OF THE PLANT PATHOLOGIST TO JULY 1, 1906

By RALPH E. SMITH.

BULLETIN No. 184.

(Berkeley, Cal., January, 1907.)

SACRAMENTO:

W. W. SHANNON, : : : : SUPERINTENDENT STATE PRINTING.

1907.

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REPORT OF THE PLANT PATHOLOGIST.

By RALPH E. SMITH.

General Review.—The present report of this Division covers a period which has been characterized by very greatly increased activity and volume of work, due to the appropriation by the last Legislature of funds for a number of special undertakings and investigations in plant pathology, the financial promotion of several special investigations by private concerns, and in general to the increased public interest in the work of this, as of other departments of the Experiment Station. These factors have contributed very materially to the growth of the Division since its establishment in 1903. Beginning at that time with the unaided services of the writer, and with practically no equipment or facilities for work, the past season has seen twelve or more assistants engaged in active field and laboratory work in the various investigations undertaken, a laboratory and office maintained at the University, a temporary laboratory in use in southern California, provision made for a permanent laboratory in the same region, and much work of value completed or begun.

Plant pathology, looked upon either as a science or from the standpoint of its economic value, has nowhere so great a field as in California. The extensive, specialized development of agriculture and horticulture, the great abundance of plant troubles and the very slight extent to which they have been studied, and the appreciative attitude of the public, afford the greatest stimulus to the professional investigator; while for the student of plant pathology the field and opportunities for study and research are unbounded and the conditions most favorable. The greatest need in the State at present, as regards plant diseases, is that of *investigation.* Not only are many of our most serious troubles peculiar to this region and their intimate nature wholly or largely unknown, but even in the case of plant diseases common to other sections, experience is continually showing that facts and methods of established value do not entirely apply here. The very artificial or unnatural conditions under which a large part of our cultivated vegetation is grown, produces unlimited and most diverse vagaries in the behavior of the plants themselves and in the conditions and agencies which affect them. Under such conditions it

has seemed more and more evident to the writer that both the demand and the opportunity are greatest for a strong department of investigation in this branch of the Experiment Station work, rather than simply a bureau of information or pedantic teaching, and it is his purpose to develop this Division along such lines.

The work of the Division since the last report has consisted mostly of several special investigations or undertakings of considerable importance, many miscellaneous examinations or minor studies, a very large amount of traveling and personal inspection on the part of the writer and his assistants, the preparation of three bulletins and a number of contributions to the horticultural and botanical press, and the handling of a rapidly increasing correspondence.

The main lines of work have been:

1. The Pear Blight investigation, founded on an appropriation by the last Legislature.

2. The Walnut Blight investigation, also provided for by special funds from the State.

3. The Lemon Rot investigation, supported by a contribution from the lemon interests of southern California.

4. The Beet Blight investigation, carried on under a fund guaranteed by the Spreckels Sugar Company, and contributed to by the other beet sugar manufacturers of the State.

5. Peach Blight and "Shot-hole Fungus" investigation, begun in a small way in 1905 and 1906, with more extensive work planned for the immediate future.

6. Tomato Disease investigation, begun in 1905 and still continuing.

7. Asparagus Rust investigation, begun in 1903 and practically completed in 1905, but still lacking in some practical details. Selection and propagation of rust-resistant varieties are also still going on.

8. Rose Disease investigation, concluded and ready for publication.

9. Citrus Disease investigation, just beginning.

Besides these special undertakings, the usual correspondence and course of the work have brought out a great variety of matters of interest regarding plant diseases, which have received more or less attention. Some of the features of interest of this sort are indicated in the article on plant diseases in this State, found elsewhere in this report. It may also be said that in this general way conditions are gradually shaping themselves for the commencement of other special investigations of a number of serious plant diseases concerning which we are at present very much in the dark. With fully equipped laboratories and permanent assistants both at Berkeley and in southern California, the Division is getting more and more into shape to handle a large amount of diversified work.

The publications issued from this Division since the last report include Bulletin No. 165, Asparagus and Asparagus Rust in California; Bulletin No. 172, Further Experience in Asparagus Rust Control; and Bulletin No. 175, Tomato Diseases in California. Numerous communications on pear blight and peach blight have been published in the horticultural press.

The volume of work which has been demanded of the Division by legislative and private sources could only have been undertaken with a considerable body of competent assistants, and it is the writer's great pleasure to testify to the efficiency and success with which those connected with the various enterprises have responded to the demands upon them. In May, 1905, Mr. A. M. West was appointed Assistant Plant Pathologist, and began work at Whittier on the walnut blight, where he has since been located. In July 1, 1905, Miss E. H. Smith received a similar appointment, and has since been in charge of the laboratory and office work at Berkeley during the writer's frequent absence. Numerous temporary assistants have been employed from time to time, of whom several have since received more permanent appointments. Mr. B. J. Jones began work on the pear blight in March, 1905, and has practically had charge of the field work during the past year, still continuing in this capacity. Mr. E. B. Babcock was employed in southern California in the lemon rot investigation during the summer of 1905, on pear blight during the winter of 1906, and again in the south up to June, 1906, when he retired to a more desirable position. Mr. R. J. McKeown is still engaged in the pear blight work, after service of more than a year. Mr. C. O. Smith worked on lemon rot during the summer of 1905, and has since assisted in the teaching at the University. Mr. H. J. Ramsey was stationed at Salinas in beginning the beet blight work in 1905, and has since been employed on lemon rot, pear blight, beet blight in 1906, and general work in southern California, being now stationed at Whittier. Messrs. T. F. Hunt and N. D. Ingram joined the pear blight force in September, 1905, remaining on that work through the campaign of the season. Mr. Ingham has since taken charge of the University Forestry Substation at Santa Monica, while Mr. Hunt has carried on the beet blight work. There have also been employed on pear blight for shorter periods, Messrs. W. H. Volck, R. Sale, O. Butler, and A. B. Mitzmain.

PEAR BLIGHT WORK.

The work of greatest magnitude undertaken has been that in the suppression of this destructive disease of pear and apple trees which has recently been so prevalent in this State. The history of the outbreak has been so often repeated that it need only be said here

that up to the summer of 1904, pear blight, except for a few scattering and unauthenticated reports, was unknown in central and northern California, although the orchards of the San Joaquin Valley and the southern part of the State had been almost wiped out several years before. In the Sacramento Valley, from San Joaquin County north, there are, or were, some 10,000 acres of the finest Bartlett pear orchards in the world. In addition to this there is a considerable acreage in Santa Cruz, Santa Clara, Alameda, Sonoma, Lake, and Napa counties, while numerous apple and pear orchards of greater or less extent are scattered far off into the mountains of El Dorado, Placer, Nevada, Sierra, Plumas, Lassen, and the other northern mountain counties.

In the spring of 1904 pear blight appeared very extensively in the Sacramento Valley. Much alarm was felt by the growers, knowing the history and result of the disease in the San Joaquin, and the Experiment Station, the various County Boards, the State Commission of Horticulture, and the U. S. Department of Agriculture were called upon for advice and relief. This Division being new at the time, consisting of the writer alone, nothing could be done during the summer of 1904 except to determine the extent of the outbreak by much traveling about through the whole northern region, and to assist the growers as much as possible by advice as to the nature of the disease and the best known treatment, and by inspecting their orchards. The blight developed extensively that summer and invaded most of the important pear districts.* In March, 1905, appropriations of the Legislature of that session made available to the Station about $10,000 for the "investigation" of pear blight during the succeeding two years. Meantime, Professor M. B. Waite, the leading authority on pear blight, had been sent to California by the U. S. Department of Agriculture, to lend all possible assistance to the growers. Considerable activity was also being displayed by the State and various County Boards of Horticulture in a desire to do what was possible toward suppressing this disease.

Recognizing the value of these sources of assistance, and the critical nature of the situation, it seemed best to the Director of the Station and to the writer in using the State appropriation, to combine all these efforts in an endeavor to apply as quickly and as generally as possible the best known methods of pear blight control, rather than to start out on an independent, necessarily extended investigation in an attempt to develop different or better methods. An arrangement was accordingly made whereby the Experiment Station, the U. S. Department of Agriculture, and the State Commission of Horticulture agreed to

*See Report of California State Board of Horticulture, 1901–02; Report of Commissioner of Horticulture, 1903-04; and Report of Thirty-first Fruit Growers' Convention of California on history of pear blight in California.

coöperate as fully as possible in the work of suppressing pear blight in the State, using the methods recommended by Mr. Waite. It should be understood that our own part in this work, utilizing the State appropriation, has consisted almost entirely in an effort to apply, or to encourage the application, as systematically and effectually as possible, of the method of treatment outlined by the Federal expert. Nor have we, save for minor additions or variations to suit local conditions, anything to offer different from the fundamental principles

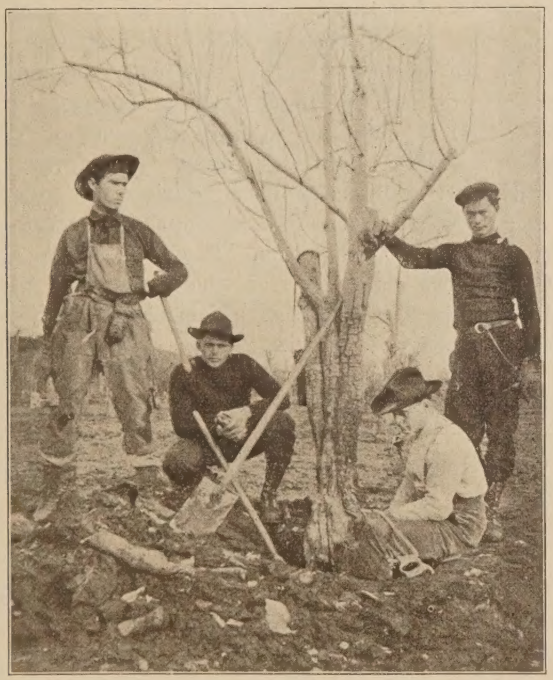

FIG. . A bad case of pear blight.

of the nature and control of pear blight laid down by Professor Waite. It is but fair to all concerned, however, to say that this State appropriation is being expended in this manner, and not, as with our other funds, in independent investigation. The plan and method of work has been taken from Mr. Waite's instructions and advice, and followed out to the best of our ability.

The general idea for the control of pear blight is very simple. It consists in inspecting the trees carefully in winter, cutting off all the affected branches below the point to which the disease has extended, and

disinfecting the cut surfaces and the tools with an antiseptic solution. Trees in which the butt is affected are to be condemned and removed. The method also insists on keeping the butt and main limbs of the trees free from all sprouts and fruit spurs, recommends a certain style of pruning, and advises as much moderation as possible in cultivation and irrigation, since a rapid growth of the tree favors the disease. Cutting out the blighted twigs as they appear in spring and summer is recommended with some reserve, the danger being that at this season when the disease is active, careless cutting or disinfecting may spread rather than eradicate the blight.* Particular stress is laid upon the necessity of complete eradication of the blight in large districts, rather than single efforts in individual orchards.

To accomplish the results desired in California it seemed necessary, (1st) to demonstrate that the blight could be successfully controlled by this means; (2d) if successful, to apply the method, systematically and thoroughly, wherever blight was present. The former object was attempted and fairly well accomplished during the spring of 1905, the season being too late, when the appropriation became available, for more extended work at that time. Professor Waite, accompanied by the writer and two assistants from the Experiment Station, went into the field early in March and gave demonstrations in the Harkey orchard near Yuba City, in Sutter County, and at the Aloha Fruit Company's orchard in Anderson Valley in Shasta County. One assistant remained at each place to continue the work. The Horticultural Commissioners of these counties coöperated very actively in the work, and aided in the expense of keeping men in their sections. Sutter County also continued several local inspectors on the work through the summer. The subsequent results in both these cases seemed to warrant the continuance of the work on a larger scale during the succeeding season. The amount of blight developing, and the damage caused by it, were everywhere in direct proportion to the work done during the winter and spring.

Early in May two more men were put into the field by the Station and experiments in summer cutting were carried on at Vacaville, in Solano County, and considerable information obtained as to the best methods of handling blight in California. During the summer the remaining northern counties were thoroughly inspected, the number and condition of the pear trees ascertained, and the locations carefully mapped preparatory to the winter campaign. Considerable was also accomplished in instructing the growers to recognize and handle the blight, and in getting into touch with the various County Boards of Horticulture. By coöperation with the State Commission of Horticul-

*For full account of the nature and control of pear blight, see Report of Thirty-first Fruit-growers' Convention of California (1905), p. 137.

ture interest was aroused in some counties which had no Board, which resulted in the appointment of such a body. In the course of the summer and early autumn seven field assistants were trained in the experimental orchard at Vacaville. This was done by a month or more of actual work at cutting out blight under competent instruction, in order that they might become familiar with every type of infection and all phases of the disease, and the most minute details of control. These men, with a few later additions, were used in the general campaign of the winter of 1905-06. The force was also augmented by a number of men from the U. S. Department of Agriculture.

The general plan of work adopted during the past winter was to locate a man or party of men in a given area and have them systematically inspect every pear and apple orchard, tree by tree, in that district. They were then to mark the trees condemned for removal on account of blight in the butt, instruct the owners in the methods of blight eradication, assist in training their help for the work, and finally to re-inspect after the work had been done. It was not the intention to have the Station or Department men do any considerable amount of actual hand labor. The district to be covered, as originally planned, included the counties of Contra Costa, Solano, Yolo, Sacramento, Placer, Sutter, Yuba, Butte, Tehama, and Shasta, this district seeming to be most in need of the work.

Before passing to the details of the work actually done and the results accomplished, it may be said in general that it was found impossible to carry on operations as systematically and thoroughly as could be desired. This was due mostly to the inability, disinclination, or actual refusal of some growers to do the work at times convenient to our limited force of inspectors, or in some cases, to do it at all. To some the method or plan of work failed to appeal; some depreciated the necessity of such radical procedure; many had poor help or none at all; some failed to see the importance of doing the work exactly according to instructions. These phases of the problem of blight control will be considered later in this report. Their result of the work of the past winter was to necessitate much duplication of inspection, a great deal of missionary work among the skeptical or dilatory element, and, in order to secure results for demonstration, a large amount of actual hand labor by the inspectors which should have been done by the growers. These features of the work were instructive in showing what can or can not be counted on in plans for the future, but caused serious delay and impairment of what it was hoped to accomplish.

In practice it was found necessary in inspecting trees for blight, not simply to walk through the orchard looking for blighted limbs as at first seemed sufficient, but each inspector had to be provided with a gouge or chisel and make a thorough examination of the butt and trunk

of every tree, in order to detect the frequent cases of hidden blight at that point. This necessitated further the condemning of many apparently healthy trees, and caused much delay, or refusal on the part of the grower, in removing them. In general, however, it may be said, that in the counties named practically every pear and apple tree was carefully inspected, every grower was seen and thoroughly instructed in the method of work, many days were spent by the men in every important orchard, a large amount of actual hand labor was performed for the sake of demonstration, and, in addition to the original territory, considerable more was covered by various members of the allied forces.

The details of the season's work may be taken up by counties, in order to show what has been done in each section.

SHASTA COUNTY.

Careful attention has been paid to this, the northernmost county of the Sacramento Valley, on account of its important pear orchards and the fact that the blight had only a slight foothold here when the work started. Our work has been greatly assisted by the coöperation of Horticultural Commissioners Weaver, Tharsing, and Lamiman, of this county. Subsequent to the preliminary work done at Anderson in the spring of 1905, the orchards of the county have been inspected twice, in the fall of 1905 and spring of 1906, and a strong effort made to aid the growers in keeping down the disease. The county has also been visited a number of times outside of the regular inspection. About 40,000 pear trees have been found and individually inspected in this county. The removal of all condemned trees has been vigorously prosecuted by the Commissioners, and almost all the growers have shown a disposition to carry out the work of blight eradication in the best possible manner.

TEHAMA COUNTY.

Conditions in this county are similar to those in the last. The same inspections have been made, in which about 34,000 trees were found and gone over. There has been little trouble to induce most of the growers to carry out the work properly, and Commissioner Coates has been very active in his official capacity. In some few cases the work has been somewhat neglected, but every grower has had ample opportunity to learn proper methods. There was considerable pear bloom in parts of the county before the winter work was completed, which resulted in considerable new infection. Conditions in general are better than in 1905. Apple trees everywhere in this county, as indeed all over the State, contain an unusual amount of infection during the present summer.

BUTTE COUNTY.

The pear acreage of this county consists mostly of a number of orchards and scattering trees about Chico, and a few large orchards in the southern part of the county. The blight had been very destructive in some of these before the present work began, and serious losses have resulted. Our own inspectors have spent considerable time in this territory, but the work there has been mostly in charge of the U. S. Department men. The pear acreage of this county is being quite considerably reduced by the blight. Horticultural Commissioner Stile has given active coöperation to the work of eradication.

SUTTER AND YUBA COUNTIES.

A considerable amount of work has been done by our inspectors in the region centering about Marysville, and the results obtained there are very typical of what may be expected from this method of blight control. The trees and orchards of this section were thoroughly inspected in the fall and early winter, and again in the spring, one man spending a large part of the season there. The various growers and their workmen were carefully instructed in the methods of work, and all the trees inspected individually (as in every case), by our own expert. He was very generally assisted by the growers and some excellent work was done, various individuals demonstrating their ability to handle this problem alone. Sutter County aided materially in sharing the expense of the work, Commissioners Stabler and Kells showing commendable activity in endeavoring to promote its general application. Commissioner Harney also coöperated on the Yuba County side. It was not entirely unfortunate that a few growers near Yuba City refused to do the work of eradication desired of them, as the evident infection radiating from these orchards after the blooming season proved an excellent object lesson to the community. Surrounding orchards received a profuse blossom infection, spreading some distance in all directions.

About 50,000 pear trees were found and individually inspected in these two counties.

PLACER COUNTY.

This county was given quite a thorough preliminary inspection during the summer of 1905, when blight was not yet very abundant, not sufficient, indeed, to arouse any great public interest in the suppression of the disease. When inspected again during the winter of 1906, it was found that a great increase in the disease had taken place. Mr. Shear, of the U. S. Department, spent considerable time in the county

at that time, but neither public nor individual interest in blight eradication has become general enough in this section to promise very satisfactory results. One of the greatest obstacles is the large number of orchards in this county which are rented to Asiatics. The blight has been very abundant on apples in the county during the present summer. About 40,000 pear trees were inspected more or less thoroughly by our men.

YOLO COUNTY.

The district about Woodland was thoroughly inspected in January, 1906, and the Winters region has been given considerable attention. After the increase in the U. S. Department force, this county was looked after by one of their men. The growers have been thoroughly instructed in the work, and are in most cases eager to apply the best methods. Conditions in this county are promising as regards holding the blight in check.

SACRAMENTO COUNTY.

In this, our largest pear-growing county, a great and fairly successful effort to control the disease has been made both by the growers and those in charge of this work. The County Horticultural Commission has been constantly active, since the first serious outbreak of blight, in endeavoring to keep down the disease, and it is largely through the personal efforts of Commissioner Cutter that the pear orchards of the great river section are in as good condition as they are to-day, judging by comparative conditions in more neglected regions which have been no more exposed than this. Under the present undertaking a considerable number of men, employed variously by the County, Experiment Station, and U. S. Department, have done a large amount of work in this section. The growers have almost all coöperated fully, and the work has gone forward more systematically than in any other large district. Operations in Sacramento County began in October, 1905, following a considerable effort on the part of the county horticultural officials during the two previous summers. The work has been done in close coöperation with the County Board, and the expense shared by it to a considerable extent. The late Wm. Johnston and his successor on the Board, Mr. Greene, both residents of the river section, were active and of great assistance in the local operations.

The work in this county during the past winter, carried on by two of our men acting as county inspectors, two other Station men, and two from the U. S. Department, resulted in the inspection of 208,300 trees (all carefully examined by several cuts in the butt with a gouge), and in addition to the inspection a large amount of the actual labor of blight removal was performed by the inspectors. Work in the main

pear district, from Rio Vista up to a point above Courtland, was completed during the winter, but some of the scattering sections were not reached. There are over 250,000 pear trees in the county. As a matter of interest as representing a fairly average condition, it may be said that in the river district the 208,300 trees inspected represented 110 growers, and 7,914 trees, or 3.8 per cent, were condemned to be destroyed. Of the growers affected, at least 100 removed their trees promptly after the inspection, and only one of the remainder made a persistent refusal. It can scarcely be claimed, however, that public sentiment is as favorable as this in all sections.

Since the winter work ceased the county has kept one of our men in the field all summer, and most of the growers have kept up a constant effort to suppress the blight.

SOLANO COUNTY.

The work in this county has been very similar to that in the preceding, and it has occupied a major portion of our time and efforts, justly so on account of the large pear acreage and the fact that the disease has been more virulent here than in any other section. Two of our inspectors received their salary from the county for several months, and Commissioners Blake, Chadbourne, and Boyce, particularly the first named, have been most active in assisting the work. Much work was done here throughout the summer of 1905 in demonstrating eradication methods and preparing for a vigorous winter campaign. For over a month in the fall, and from December to March, four and five men were constantly busy in Vaca Valley, much of the time actually cutting out blight and always endeavoring to spread a knowledge of the methods among the growers. The problem in this section is a most difficult one, owing to the very badly affected condition of most of the orchards, and the disposition of the growers to take an indifferent or hopeless attitude as to the possibility of controlling the disease. Conditions are worse, and we have done more work in this district than in any other. For the sake of getting any complete demonstration it was finally necessary to select a certain natural section of the valley for the work, and much of the time of our inspectors was spent in doing all the actual work of blight eradication in these orchards at no expense to the owners. A few growers, however, assisted in the latter respect.

The demonstration aimed at here was sufficient to justify the effort. Those orchards which were not well cleaned or were left untouched during the winter received an unusual amount of early blossom blight, while those in the section well worked received only a very little of this from these neighbors. This carried infection over into the late bloom and new growth, but by close and careful summer cutting a

number of growers have succeeded in saving their crops and trees at a comparatively trifling expense. Most of the neglected orchards are past redemption.

Two men were stationed at Vacaville through the spring of 1906, following up the development and spread of the blight. Altogether we have inspected some 200,000 trees in this county, but this by no means represents the amount of work done on account of the large amount of labor performed by the inspectors, and the experimental work carried on in this district.

Conditions in the other pear sections of the county, the Suisun Valley, are much more encouraging than at Vacaville, the blight having reached here a year later, after the present work was under way.

CONTRA COSTA COUNTY.

There are about 75,000 pear trees in this county and they have as yet been only slightly affected with blight in a few orchards. We have inspected the county twice and instructed the growers in the methods of work. They are practically unanimous in pushing the work. Commissioners Tevan and Sutton have coöperated actively.

LAKE COUNTY.

Blight is present in this county and requires attention. Mr. Swingle, of the U. S. Department, spent a few days there in the spring of 1906, and we have had considerable correspondence with various growers, but the county has not been systematically worked.

EL DORADO AND NEVADA COUNTIES.

These counties have received only a little attention. Blight is present.

SAN LUIS OBISPO AND MONTEREY COUNTIES.

These counties have no extensive pear orchards, but blight is abundant in those which occur.

SANTA CRUZ COUNTY.

Blight has been found in this county and should be closely watched, on account of the apple industry.

SAN BENITO COUNTY.

Blight has been found.

ALAMEDA AND SANTA CLARA COUNTIES.

We have given the orchards of these counties considerable inspection and found no cases of the disease. It will almost certainly enter

Santa Clara from the south in the near future, and should be carefully watched for.

OTHER COUNTIES.

In the remainder of the State where pears are grown the blight problem is not pressing, mostly because the disease has already ruined the orchards. Concerning Napa County we have no very definite information, but the disease undoubtedly exists there.

In southern California the blight is attracting renewed attention on account of attacking apple trees in the mountain districts.

GENERAL CONCLUSIONS REGARDING PEAR BLIGHT ERADICATION OR CONTROL IN CALIFORNIA.

In the preceding paragraphs we have shown what has been done during the first year of the work, under the plan of operation adopted. It is but reasonable that a report of this nature should indicate something as to the prospects and plans for the future.

We feel satisfied that the method of treatment adopted is not likely to be improved upon, save perhaps in some details. We have followed out some lines of original investigation to a limited extent, and hope to push them further; we have also obtained observations of value on local features of the blight, but the general principles laid down still hold. The pear-growers of California, and we whose province it is to assist them, must look the problem in the face and make the most of the circumstances. Avoiding undue enthusiasm and extravagant claims, we feel justified in saying that in our experience in the control of pear blight since 1904 this much has been established:

1. That thorough work in winter eradication prevents blossom-infection in spring.

2. That the larger the district which can be covered in winter the less will be the infection next spring, and all the infection will come from blight which remained over winter.

3. That so long as sources of infection remain over winter, producing infection even in well-worked orchards near by, frequent, prompt summer cutting and removal of butt sprouts and spurs must be practiced in order to prevent serious damage and loss of trees.

4. That if not exposed to extremely abundant infection from neglected trees near by, a pear orchard can be profitably maintained in good condition and cultivated, pruned, and irrigated in the manner necessary to secure a crop, by thorough winter blight work and prompt summer cutting and sprout removal. The farther away the blight can be held the less will be the trouble.

The general application of the work requires, with all growers *education*, with some *persuasion*, with a few *force*. Practically the

greatest difficulty in a general, systematic clean-up has been to induce the growers to do the work with any degree of efficiency and sufficiently early in the winter so that our inspectors could thoroughly examine the orchards and get the remaining cases out before the new season arrived. It is often difficult to get help to do the work properly, or the owner does not realize its importance. The varying quality of human nature in this regard can only be partially improved by exhortation and argument. Few actually refuse to do the work, but many slight or postpone it. This is the most serious difficulty to be met. Our horticultural law gives the County Commissioners power to force the work, and in a few counties this has been done to great advantage, but in general the varying status of the Boards in different counties, and the not unnatural disinclination of local members to create trouble with their neighbors, render hopeless the general application of the law under present conditions.

It appears to the writer that the desired end is most likely to be attained by stationing permanent, competent inspectors in the various pear-growing centers under State authority, and keeping them there the year round to aid, instruct, urge, and encourage the growers in blight eradication. In the larger districts this force should be supplemented at county expense. Outside aid, such as that from the U. S. Department of Agriculture, could be distributed to the best advantage in the State.

With such a force of local inspectors, especially if given authority to enforce blight eradication, conditions should be so adjusted as to assure the competency of these men, and their supervision by expert authority.

It is hoped to adopt this method as far as possible during the coming year, stationing the men available more permanently and with less idea of covering the whole territory in regular order than was the case last year. This will afford all growers who desire aid, every opportunity of obtaining it; but in large districts will put the responsibility of how much is accomplished toward a general clean-up more upon the growers and the county.

WALNUT BLIGHT INVESTIGATION.

The walnut blight is a very serious disease of the English walnut, which occurs all over California, but reaches particular importance in the southern part of the State where the commercial crop is principally grown. Unlike pear blight it does not usually affect the life or vitality of the tree to any serious extent, but exerts its harmful effect on the amount and quantity of the crop, varying from year to year in prevalence. An orchard may be very badly affected this year, and the same trees produce an abundant harvest a year or two later.

A reduction of fifty per cent or more in this valuable crop is often occasioned by the blight.

The disease is said to be unknown save on the Pacific Coast, and has been previously studied only by Professor Pierce, of the U. S. Department of Agriculture, while stationed at Santa Ana, Cal. The latter has shown the blight to be of a bacterial nature, caused by an organism named by him *Pseudomonas juglandis*. This was proved by Professor Pierce to be the active, sole cause of the blight by isolation of the organism from diseased tissues, and by the artificial production of the disease from inoculations with the germ from cultures. A

FIG. 2. Bacterial Blight of Walnuts.

reduction of fifty per cent in the occurrence of the disease has been shown by this investigator as a result of spraying twice with Bordeaux mixture, after first removing the affected twigs from the tree. The growers as a whole, however, except in a very few instances, are attempting no treatment for the blight and feel deeply concerned at its ravages. The disease produces black, cankered spots on the young nuts, causing them to fall prematurely or spoiling the kernel. (Fig. 2.) Similar spots also appear on the youngest, green, new shoots (see Fig. 3), but these heal out as the wood hardens, not continuing down the twig. In bad years, however, a large portion of the terminal growth (the shoots which should bear the crop next year) is killed in this way.

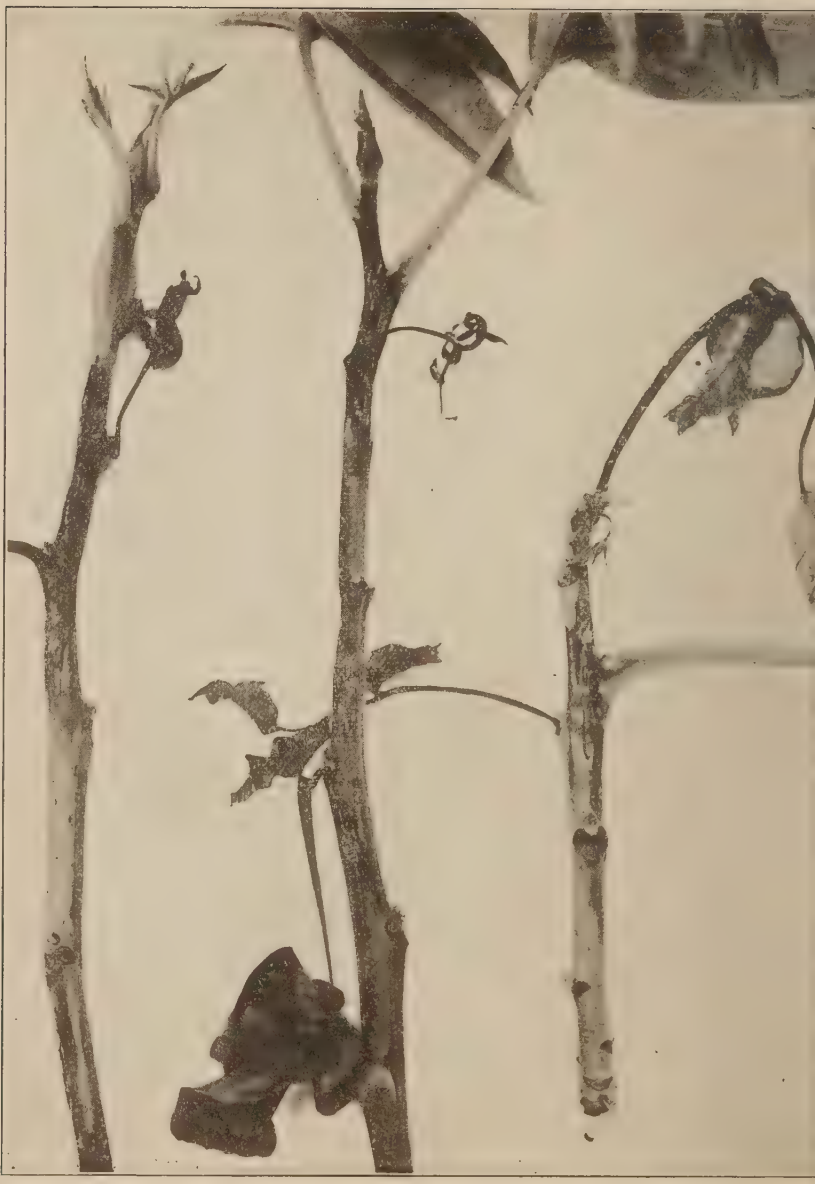

FIG. 8. Blighted walnut twigs.

An appropriation was made by the last Legislature for the investigation of this disease, which fact determined the first work to be taken up by the Pathological Laboratory for southern California, established at the same time. Temporary quarters were obtained through the courtesy of the Whittier Board of Trade, and one assistant has been constantly employed on this work since May, 1905. The writer has also given much personal attention to this investigation, and other help has been added from time to time. The work of the past year has consisted in a bacteriological study of the organism causing the disease, (Pierce's determination in this respect being substantiated

FIG. 4. Spraying for Walnut Blight in Spring of 1906.

by our results), a series of spraying experiments on quite an extensive scale, study of the development, spread, etc., of the blight in the orchard, and general study of the walnut and its culture. We will not attempt to discuss here at length the disease or details of the investigation, which still continues. Results thus far have shown that the trouble is a peculiarly difficult one to control for a number of reasons. The results of our spraying experiments do not appear at all promising, though this will be continued another year. Even were they very favorable, the size of the walnut tree makes spraying almost prohibitive on account of the expense and difficulty. An *immune variety* is very feasible, as trees vary greatly in susceptibility to the disease, but this will not help the existing acreage. Our work will take up this

phase of the problem. Careful study will be made of the condition of the blight organism during the winter, and the manner of the first infection in spring, hoping in this way to obtain some suggestion as to a preventive treatment.

LEMON ROT INVESTIGATION.

This work was undertaken in June, 1905, at the request of the "Lemon Men's Club," of Southern California, and supported in part by a financial contribution from the same source. Since the establish-

FIG. 5. Brown Rot of Lemons. Untreated Lemons. (Decayed fruit in boxes at left.)

ment of the temporary laboratory at Whittier, it has been possible to do much of the work there to good advantage, in connection with observations and experiments in various packing houses and orchards. The work was begun at the Limoneira Lemon Company's establishment at Santa Paula.

The trouble in question is a peculiarly virulent, rapid-spreading decay of lemons in the packing house and marketing box. It has been named the "brown rot" by the growers, in distinction to the ordinary "blue mold" (*Penicillium*) rot. The growers and packers knew it as something very much more virulent than the latter, but this was the entire extent of information as to the nature of the trouble, and means of checking it were entirely lacking. Losses of ten per cent of the entire

crop before shipment were experienced in many instances, besides a large amount of extra handling being required, and frequent excessive losses in shipment. The particularly disastrous feature of this form of decay consisted in its very rapid spread through the boxes; one affected lemon soon infecting a whole box, if not removed. The lemon growers of the south lost upwards of $75,000 in the season of 1904-05 from this form of decay, above all other rot and shrinkage. The trouble also occurs in the orchard to some extent in wet weather.

A large volume of work has been done in this investigation by

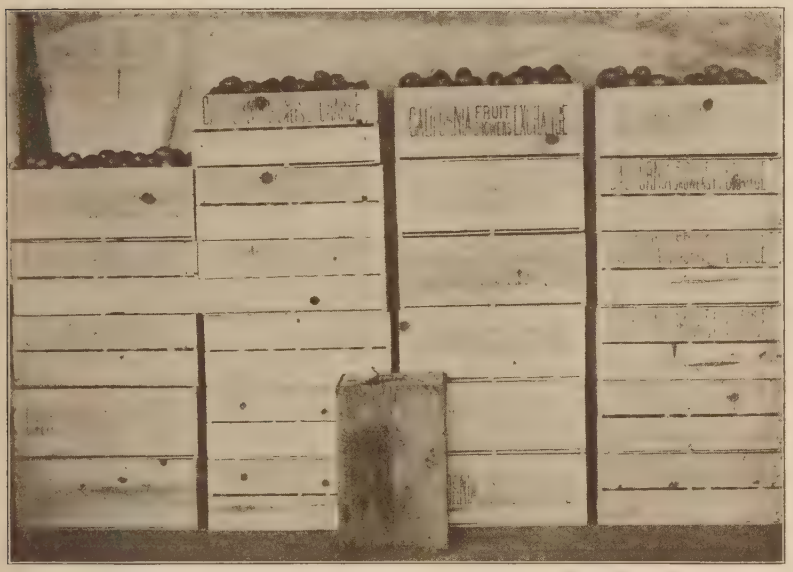

FIG. 6. Brown Rot of Lemons. Wash-water disinfected. (One decayed lemon.)

several different assistants, and the problem as to the nature and control of the rot seems to be well toward satisfactory solution. The cause of the trouble was soon discovered, and found to be a fungus not hitherto described. This interesting organism has been named *Pythiacystis citrophthora* and a description published in the "Botanical Gazette." The investigation has revealed something entirely unsuspected by the growers, namely, that the spores of this fungus are not developed upon the lemon at all, but entirely in the soil beneath the trees in the orchard. Some fruit becomes infected in wet weather while still on the tree, but the chief source of infection was found in the water of the washing tank, which becomes very badly infested at times with spores of the fungus brought in with the dust and dirt from the orchard. A lemon once affected and stored away in the box, infects

FIG. 7. Beet Blight.

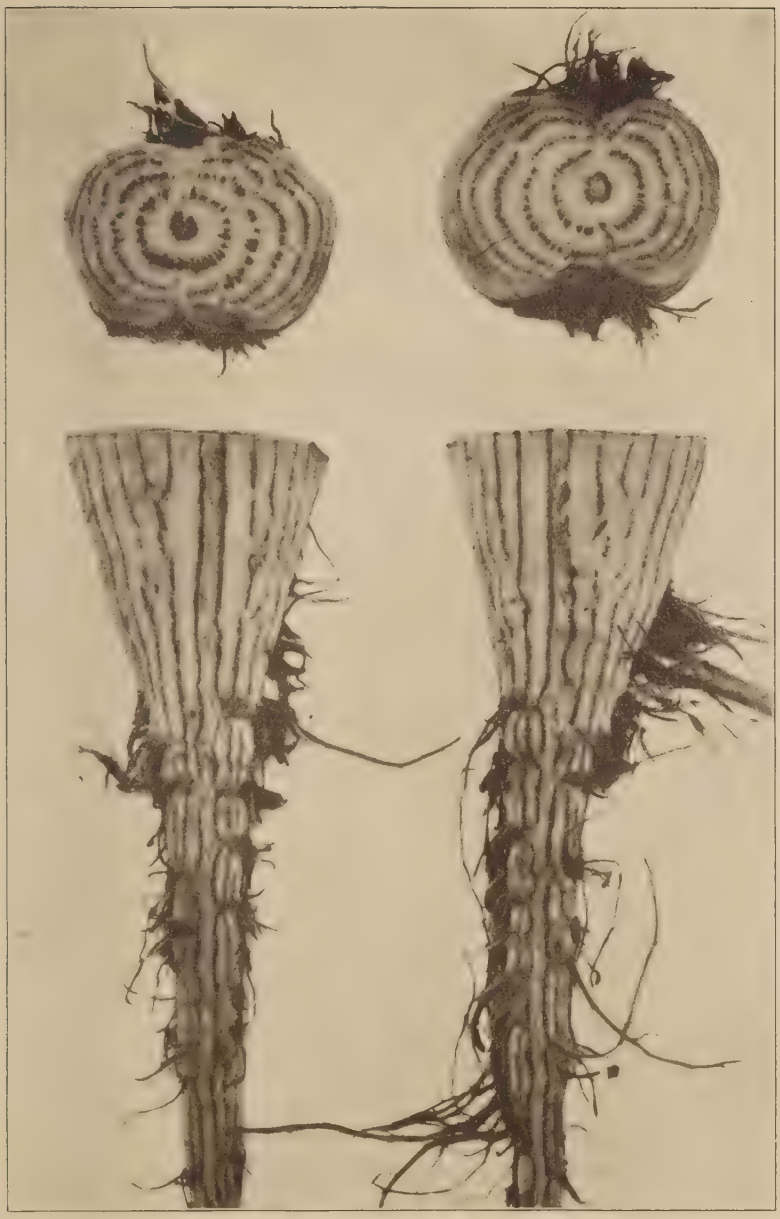

FIG. 8. Beet Blight.

its neighbors very rapidly by direct, vegetative growth of the mold-like fungus from one fruit to another (Fig. 5), but no spores whatever are formed under such conditions and infection can only take place by contact.

Extensive experiments have been carried on in disinfecting the wash-water so as to kill the fungus without injuring the fruit, and a method worked out of accomplishing this which has been put into practice with good results in practically every lemon house in the State (Fig. 6).

It has also been found possible to check the development of the rot fungus in the orchard soil by simple cultural means, and this is being further developed. The work as a whole is in very satisfactory condition.

BEET BLIGHT INVESTIGATION.

The blight, or "curly top," of the sugar beet is a disease which has been known in the semi-arid portions of this country for a number of years, and caused much speculation as to its nature. On this coast the disease has been the cause of serious losses in certain seasons for some time, and the growers have been entirely in the dark as to the nature or handling of the disease. In the spring of 1905 the trouble began to appear abundantly in certain sections, and the attention of the writer was called to the need of information concerning this disease by Dr. G. W. Shaw, of this Station. In response to a suggestion made to the Spreckels Sugar Company that company made a financial guarantee to the Station for the purpose of enabling us to begin a study of the blight, in order that they might obtain some information in the practical handling of the disease. This fund was subscribed to by the other beet sugar manufacturers of the State.

The disease in question is a peculiar stunting or non-development of the plant, occurring often under conditions apparently very favorable for growth. Some years in large areas the plants stop growing, the leaves curl and crinkle in a peculiar manner (Fig. 7), the roots become blackened in the internal rings (Fig. 8), and soon the whole crop is a complete loss. The disease has been studied more or less in different places, but its cause has never been discovered.

An assistant was stationed at Salinas in the summer of 1905, working on the problem there in connection with laboratory studies made at the University at Berkeley. Observations were also made in the other beet sections of the State. This work was continued so long as conditions were present for continuing the investigation, and commenced again early in the spring of 1906, and is still continuing. The pathological and field work has been in charge of this Division, while Professor Shaw has carried on a series of moisture determinations and investigation of soil conditions, laying out a series of plantings for this purpose.

The conclusion reached, and substantiated by a great variety of field and laboratory investigations, observations and experiments extending over two seasons, has been that the trouble is not brought about by any parasite or organism, but is rather due to a derangement in the normal functions of the plant which can not be fully explained. The disease has a very marked relation to moisture and climate, especially rainfall at certain seasons, but presents many very peculiar features. It is a very definite disease, with characteristic symptoms, and not simply the injurious effect of unfavorable conditions. The disease is one of a number of so-called "physiological" plant diseases, and resembles in some features similar diseases of the tobacco, China aster, and other plants.

Considerable practical benefit seems to have been derived from the investigation of this disease, as we have been able to point out to the growers how they may largely avoid the trouble by planting and cultural practice in certain relations to weather conditions. There is reason to hope that in the future the trouble can be almost entirely avoided by this means unless extremely unusual weather conditions occur.

It is hoped to continue the study of the exact nature of the disease, as a better understanding of this whole class of plant diseases would be of great practical and technical interest.

PEACH BLIGHT AND "SHOT-HOLE FUNGUS" INVESTIGATION.

The serious development of the so-called peach blight during the past two seasons has rendered it imperative for us to seek more light on the nature and means of control of this disease. (Fig. 9.) The writer gave the matter some attention during the season of 1905, and in the spring of 1906 an assistant spent considerable time in the field investigating conditions in regard to this disease. The fungus has been studied in the laboratories at Berkeley and Whittier, and arrangements made for quite extensive field experiments in a number of places during the coming season. Spraying with Bordeaux mixture in December has proved so effective in controlling this disease that we hope to make very complete demonstrations during the season of 1906-07. (Fig. 10.)

The "shot-hole fungus" of the apricot, caused by the same parasite (*Coryneum*), is the cause of great loss in this crop, and it has been our intention to include this also in the same investigation. Experiments in spraying planned for 1906 were largely a failure owing to excessive rains at the proposed time for spraying, and to the almost total failure of the crop in many districts. This work will be continued, however, another year along with the peach work. The almond is also badly affected with the same disease. There is an excellent field for investigation in the relation of the *Coryneum* fungus to the various stone fruits.

FIG. 9. Peach Blight (*Coryneum*). Unsprayed tree.

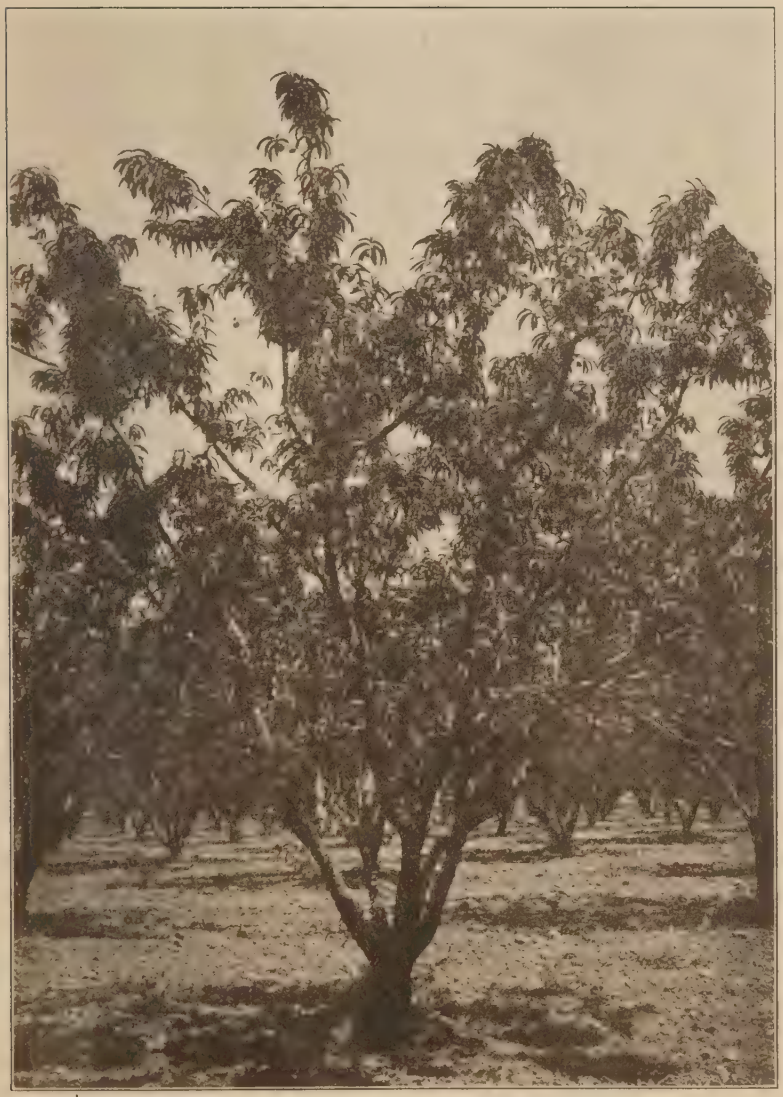

FIG. 10. Peach Blight (*Coryneum*). Trees sprayed with Bordeaux mixture.

TOMATO DISEASE INVESTIGATION.

Considerable work is being done, particularly in southern California, in the investigation of tomato diseases. Bulletin No. 175 has been published on the subject as a preliminary report. During 1906 a disease not mentioned in this bulletin has proved quite serious; this is the "Blossom-end Rot," seemingly an active bacterial disease as occurring this year. (Fig. 11.) The summer blight or wilt, a *Fusarium* fungus

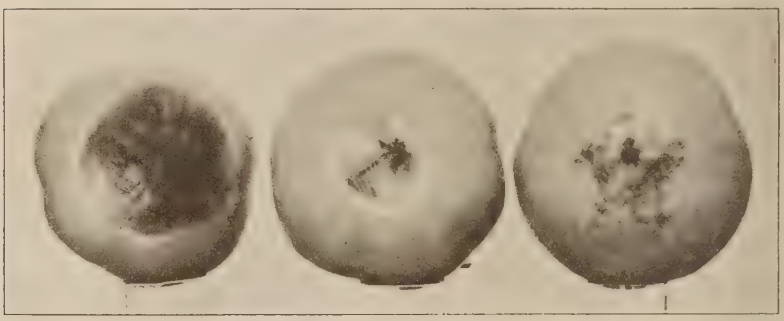

FIG. 11. Tomato Fruit Rot.

disease, is our most serious tomato trouble in the ordinary course of events, and stands much in need of the study which we are now prepared to give it at the Whittier laboratory. Spraying demonstrations for the control of late blight, caused by the potato fungus *Phytophthora,* will also be carried on in the same section which is a center of tomato growing.

ASPARAGUS RUST.

This work, the earliest undertaking of this Division in the State, is still receiving some attention. The results of the treatment recommended as a result of the investigation were particularly good in 1905, preventing the rust entirely in large fields when the disease was abundant on all sides. Work with resistant varieties and in applying the method of treatment to various conditions is still continuing.

ROSE DISEASES.

This subject has been made the subject of some study and experiment, and material obtained for a bulletin on the subject. A very common and destructive disease has been found in the State which has never been previously reported, the nature of other troubles determined, and a method of treatment developed which has features of superiority over any present practice.

CITRUS DISEASE INVESTIGATION.

With the founding of the laboratory for southern California, opportunity is afforded for what has long been a pressing need in that section, a general investigation of citrus diseases. Particularly the so-called "Gum Disease" requires much careful study. This work is now being entered upon and will be prosecuted vigorously.

OTHER INVESTIGATIONS, PRESENT AND FUTURE.

The above includes the principal lines of work engaged in up to July, 1906. Many other matters, however, are constantly receiving attention in the laboratory and field, amounting in the aggregate to nearly as much as the special investigations. Some of these subjects are greatly in need of more special consideration, and will no doubt receive it soon with our increased facilities. The root rot or "Oak Fungus" disease of various fruits, the apple mildew and scab, the melon wilt, onion mildew, and a number of others may be included in this class. All these and others are frequent subjects of inquiry to which we can give no satisfactory answers. Too much, however, must not be undertaken at once or the work allowed to become superficial, as is the tendency under such conditions as ours. What is needed is accurate, thorough investigation, the accomplishments and results of which can not be measured or predetermined by time, resources or anything but the quality of the work itself and the nature of the problem. One undertaking may result in a brilliant success almost immediately, and another give no practical results whatever after long-continued effort made with equal or superior ability.

The preparation of the present report has been largely contributed to by several of my assistants, particularly Messrs. B. J. Jones, A. M. West, H. J. Ramsey, T. F. Hunt, E. B. Babcock, and Miss E. H. Smith.

PLANT DISEASES OF CALIFORNIA.

The following list, while not compiled with the idea of absolute completeness, may be of some value in indicating the ordinary plant diseases of the State, and the comparative occurrence of some which are most important in other parts of the country. The list will also serve as a basis for a more complete synopsis, to be added to from time to time. No distinction is made as to the cause of disease, fungus or otherwise, the writer wishing to lessen the tendency to make plant pathology synonymous with the study of parasitic fungi.

POME FRUITS.

APPLE.

Powdery Mildew (Podosphaera oxyacanthae).—This is one of the most serious apple troubles in the State. The new growth is attacked, with a stunting effect in spring, and the blossoms considerably injured. The disease occurs all over the State, particularly in the mountain and coast regions.

Scab (Venturia inaequalis).—Apple scab has only recently become general in the State, appearing first in the mountain regions. It is more prevalent than ever before during the present season.

Blight (Bacillus amylovorus).—The disease, more commonly called pear blight, has attacked apples with unusual virulence during 1906. This is particularly the case in the mountain regions, both north and south.

Root Rot and "Toadstool" or "Oak Fungus" Disease.—This trouble is severe on apples in the northern mountain districts. At least two distinct diseases may be recognized, one a decay of the roots and lower trunk, caused by perhaps more than one species of toadstool fungus coming from the soil. There is apparently some ground for the popular idea that this disease occurs more frequently on ground where oak trees formerly stood. The native oaks are frequently attacked in a similar manner. The second form of disease appears to come about through infection at wounds or pruning scars on the trunk, the fungus running down into the heart of the limbs and trunk and thence into the cambium and bark. From recent observations we are led to believe that the little toadstool fungus, *Schizophyllum commune*, is the cause of this trouble.

"Baldwin Spot."—This, or a similar trouble, marked by the appearance of sunken, discolored spots on the surface of the fruit, is common on a number of varieties of apple, and of serious importance. The cause is not known.

Crown Gall.—This trouble gives much trouble in nurseries, but apparently does not result as seriously in the orchard tree as with the similar disease on stone fruits.

Canker, Rots, etc.—The various diseases of this sort which are prevalent in many parts of the country, either do not occur or are not conspicuous in California.

PEAR.

Scab (Venturia pirina).—This has been the greatest obstacle to pear production in the State, causing immense losses in quality and quantity in many seasons. The disease is of comparatively recent occurrence in many sections, but is now practically universal. Preventive spraying is not always successful, owing to prevalence of rain at the proper season. The trouble was extremely abundant in 1906.

Blight (Bacillus amylovorus).—This disease now invades all except a very small section of the State, and menaces the pear industry. Great efforts are being made for its suppression.

Leaf Blight (Entomosporium).—This disease has not been observed in the State.

Crown Gall.—Quite uncommon on pears.

LOQUAT.

Blight (Bacillus amylovorus).—Pear blight affects the loquat quite seriously in some instances.

QUINCE.

Blight (Bacillus amylovorus).—Quinces are also affected by this disease when considerably exposed to infection.

STONE FRUITS.

Owing to the various combinations as to root made in propagating these trees, as well as their close relationship, the various species may be considered collectively as regards the diseases to which they are subject.

ALMOND, APRICOT, CHERRY, PEACH, PLUM, PRUNE.

Crown Gall.—Common and injurious on all the stone fruits, both in orchard and nursery.

Root Rot ("Toadstool").—Serious in many sections, causing trees to die in gradually enlarging areas in the orchard. Apparently caused by more than one species of toadstool.

Root Knot (Nematode).—Occurs sometimes in nurseries on these and other plants, but not general and not an orchard pest.

Brown Rot (Monilia).—This is not yet a serious pest in California, and is greatly held in check by the rainless summer season. During the past two seasons of late spring rains, however, the rot has been quite abundant and destructive on apricots, some plums, and early peaches, especially near the coast. Monilia was probably more prevalent in the State in the spring of 1906 than ever before, and in general seems to be gradually gaining in prevalence. Considerable damage to the young twigs of apricots occurred from this cause during the past spring. Cherries are not affected, so far as the writer has observed.

Leaf Curl (Exoascus deformans).—This disease is extremely prevalent in the State on peaches almost every year, but is readily controlled by proper spraying.

A similar disease on plum has been observed, but the peach is commonly the only fruit affected in this manner.

Mildew (Podosphaera oxyacanthae).—This is seen rather commonly on peach, but can hardly be called a serious pest.

Blight; Shot-hole Fungus (Coryneum).—This trouble has been extremely severe on peaches throughout most of the State in 1905 and 1906. The fruiting wood becomes badly infected, causing gumming and the death of the buds. Apricots are attacked by apparently the same fungus, but with a somewhat different effect, a scabbing of the fruit being the most conspicuous symptom. Many of the buds are killed as on peaches, but the gumming of the twigs is much less pronounced. The scabby effect is seen to some extent on the fruit of the peach, when the disease is very prevalent. On the almond the leaves are most affected, showing a shot-hole effect and dropping from the tree. Apricot leaves also become perforated, but do not fall.

Cherries, plums, and prunes are not so commonly affected.

Other shot-hole fungi than the *Coryneum* occur in the State, but have not been conspicuous in recent years.

Rust (Puccinia pruni).—The prune rust is abundant in California, but rarely becomes a pest save in the drier, southern portions. In most sections where sufficient water is available throughout the summer, the rust appears only in fall, on the leaves which are about to fall from natural maturity. In dry regions, however, where the trees suffer for water, the rust sometimes appears quite early and causes the foliage to fall. Peaches, plums, prunes, and occasionally almonds are affected.

Sour Sap.—Under this name is popularly known a common and serious trouble with stone fruits. The disease is characterized by the sudden death of a tree or branch in full leaf, commonly in the early spring. It is not a gradual sickening or dying, as may occur under any unfavorable conditions, but a sudden withering of a healthy, vigorous tree. Apricots and prunes are most commonly affected, sometimes other stone fruits. There is no evidence of any parasite or organism in con-

nection with the disease, but it appears rather to be brought about by certain weather conditions, typically a period of cold, wet weather following an unseasonably warm period in early spring. Apparently a very vigorous activity is started in the tree and then suddenly checked, resulting in a stagnation and subsequent fermentation of the sap. Primarily the trouble is purely functional from all appearances.

Die Back, and Dying in Spots.—These general terms include many cases of troubles with stone fruits in which the trees gradually die from the top from no cause above ground. Hardpan, alkali, changes in water level, dry soil, and various other unfavorable conditions are responsible for cases which are not due to crown gall, root rot, or insect or gopher attacks. The "dying in spots" referred to is seen in many prune, peach, apricot, almond, and cherry orchards, where the trees in certain areas survive only up to a certain age, then gradually dying back from the top. The cause is usually one of the above named.

Split Pit.—This disease is seen principally in peaches, and shows itself as a cracking and shattering of the pit of the mature fruit, commencing, however, when the peach is very young. The characteristic effect is more than simply a separation of the two halves of the pit, showing as a cracking of the whole stone into small fragments. A gumming, which breaks out on the surface of the fruit, usually accompanies the trouble. The cause appears to be physiological rather than the effect of any parasitic organism.

Seasonal Effects.—One of the most common of troubles with fruit trees in the State is that produced by the vagaries of our mildly uncertain climate. Particularly in the coast regions of southern California do the peaches and their relatives, as also the apples and walnuts, lose complete reckoning of the season and suffer accordingly. Trees blooming in fall, remaining bare until July or August, bearing two crops of fruit a year and showing other evidences of confusion is the result. This has a disastrous effect, resulting usually in a dying back to the main fork or larger limbs. Several uniform seasons following this may enable the tree to form a new top again. A great many orchards, particularly of peach, apple and hard-shelled walnuts were killed or badly injured in this way in the season of 1903-04: in 1904-05 they became still more affected, but in 1905-06 normal conditions more nearly prevailed. Different varieties of fruit are variously affected: the "Saucer" or Peento peach being notably unaffected.

Of stone fruit diseases of serious importance in other parts of the country, the Peach Yellows, Little Peach, and Rosette, the Peach Scab (*Cladosporium*) Black Knot (*Plowrightia*) of the plum and cherry, and the Plum Pockets (*Exoascus*) are not known to the writer to occur in California.

SMALL FRUITS.

Diseases of the small fruits are not abundant in California, but a few may be mentioned.

BLACKBERRY.

Rust (*Gymnoconia interstitalis*).—Blackberry rust is common in the State and conspicuous by the powdery mass of bright orange-colored spores which it produces on the lower side of the leaves.

CURRANT.

Mildew (*Sphaerotheca mors-uvae?*).—This powdery mildew attacks currants quite commonly.

DEWBERRY, LOGANBERRY.

Leaf Spot.—These fruits are considerably attacked by a fungous leaf spot.

Fruit Rot (*Botrytis cinerea*).—The common *Botrytis* mold caused considerable decay of ripe berries during the past season.

STRAWBERRY.

Leaf Spot (*Sphaerella*).—This disease, causing numerous purple dead spots on the leaves, is rather common.

SUBTROPICAL FRUITS.

ORANGE, LEMON, POMELO.

The diseases of citrus fruits in California have heretofore received but little attention. The common troubles may be named, but in several cases this is the extent of existing information.

Blue Mold (*Penicillium*).—This is the common form of citrus decay. Examination shows that two species of *Penicillium* are present and about equally abundant: *P. glaucum*, the blue-green form, and *P. digitatum*, the olive-green. The species are quite distinct, both biologically and morphologically. Powell's recent work on citrus decay in transportation has shown that there is little or no infection from these molds save in bruised fruit.

Brown Rot (*Pythiacystis citrophthora, n. sp.*).—This form of decay, which is principally confined to lemons, has been recently investigated by this Division, as indicated elsewhere. It has been extremely virulent.

Gum Disease (Fig. 12).—This is the only common citrus tree disease in the State. It occasions large losses in lemons, and some in oranges. The disease manifests itself in exudations of gum from the trunk, commonly stopping abruptly at the crown. The gum breaks out through the bark, the cambium and inner bark become disorganized, and

in severe cases the tree dies. Other less severe cases recover, or are helped by cleaning out the affected bark and painting over the wound with an antiseptic. The disease is not primarily a root rot, and the root, in most cases, does not become affected. The trouble occurs in trees in poorly drained situations or otherwise under unfavorable con-

FIG. 12. Gum Disease of Citrus Trees.

ditions. So far as our observations have shown it is a purely functional disorder and not produced at all by any parasitic organism.

A somewhat different form of gum disease also occurs, in which the breaking out of the gum occurs from the limbs of the tree, rather than from the main trunk near the ground.

Die Back.—Various forms of citrus disease characterized by this general term occur in California, but there is no trouble of this sort

of a very definite nature. "Die back" is not a common, characteristic, or serious trouble in the State. There is particularly no fungous disease of this sort which is at all common.

Puffy Orange.—This is a trouble which affects particularly the Washington Navel in certain seasons, exhibiting itself as a "puffiness," or wrinkling, expansion, and sponginess of the skin. The interior becomes structureless and insipid. The trouble is physiological and produced by an abnormal development from some cause not well understood.

OLIVE.

Tuberculosis (*Bacillus oleae*).—This bacterial disease of the olive has previously occasioned considerable alarm in the State, but experience has proved it to be not a very serious or destructive trouble. The disease is fairly abundant, particularly in the Sacramento Valley, but is not the cause of any severe commercial damage.

VEGETABLES AND FIELD CROPS.

ASPARAGUS.

Rust (*Puccinia asparagi*).—Asparagus rust continues to prevail in the State and has been the cause of very severe losses in this crop. The disease has been fully as severe as ever during the past season. The treatment recommended by this Station has proven successful in many instances where properly carried out, but a large acreage of the crop is rapidly succumbing to the disease.

BEAN.

Anthracnose (*Colletotrichum lindemuthianum*).—This disease, which produces a spotting or rusting of the pods of string beans, can not be called a serious pest in California. It is much less abundant than in most parts of the country.

Rust (*Uromyces appendiculatus*).—The true red rust of the bean occurs sometimes on bush beans and causes more or less damage. It was quite abundant in 1906.

Powdery Mildew (*Erysiphe polygoni*).—This disease is not uncommon on bush beans and occasionally causes damage.

The white lima, our principal bean crop and one of the large industries of California, is notable for its freedom from fungus diseases and injurious pests of every sort.

BEET.

Blight or Curly Top.—This serious sugar-beet disease occurs very destructively in the State during certain seasons. Its development was rather limited in 1906. The disease, from considerable investigation by

this Station, appears to be of a physiological rather than a parasitic nature, brought about by climatic and other natural conditions.

Leaf Spot (*Cercospora beticola*).—The leaf spot of the beet is not serious or destructive in this State. On the sugar beet it is practically or wholly unknown.

Root Rot.—A root rot of sugar beet seedlings occurs quite largely in wet weather. Affected plants usually recover, but produce a branched and misshapen root as a result of the injury to the original tap root. The trouble appears to be due to a form of *Rhizoctonia.*

Rust (*Uromyces betae*).—This disease is found quite commonly on the leaves of table beets which are left in the ground over winter. It is not at all serious.

Nematode Worm (*Heterodera radicicola*).—This serious trouble of sugar beets in Germany has been observed in California, but has not thus far occurred in serious abundance.

CABBAGE, TURNIP, RADISH.

Club Foot (*Plasmodiophora brassicae*).—This trouble, which produces large swellings or tumors on the roots of these plants, occurs in this State but is not at all common.

White Rust (*Cystopus candidus*).—This fungus is common in the State on the shepherd's purse, an allied plant of the cabbage family.

Black Rot (*Pseudomonas campestris*).—This bacterial disease of the cabbage and similar plants is not known to the writer to occur in California.

CELERY.

Leaf Blight (*Septoria petroselini*).—This disease occurs to a considerable extent in the large celery districts of the State.

CUCUMBER.

The out-of-door crop of cucumbers in the State is not seriously affected by any disease. As grown to a limited extent in greenhouses, the following troubles occur:

Powdery Mildew (*Erysiphe polygoni*).—This is not uncommon, but of no serious importance.

Nematode Worm (*Heterodera radicicola*). The root-knot trouble caused by these pests has been seen in the case of one greenhouse in the State.

Stem Rot (*Sclerotinia libertiana*).—This disease, causing a rotting of the stem at the surface of the ground, has been seen in one instance.

MELON.

Wilt, Stem Rot (*Fusarium*).—Both cantaloupes and watermelons are seriously affected in this State by a wilting and dying of the plant, caused by a species of *Fusarium.*

ONION.

Downy Mildew (*Peronospora schleidiana*).—In the great onion seed farms of the State this disease is frequently the cause of severe loss during the wet winter months.

PEA.

Powdery Mildew (*Erysiphe polygoni*).—The pea mildew is common and more or less troublesome on crops grown in the rainy season.

POTATO.

Blight (*Phytophthora infestans*).—Potato blight occurs in the State in more or less abundance in the foggy coast districts and during the rainy season. In general the main potato crop of the State is entirely free from this disease.

Rhizoctonia Disease.—This is common in the State, but of very little serious importance.

Scab (*Oospora scabies*).—Potato scab is common in California, but a less serious pest than in many other sections.

Stem Rot, Dry Rot (*Fusarium*).—This disease, showing as a wilting and dying of the potato plants and blackening and dry rot of the tubers, is our most serious potato trouble. It is not, however, abundant in the most important potato sections, but appears to develop most freely in the foothill and mountainous regions, where the crop is grown in a limited manner.

SQUASH, PUMPKIN.

Bacterial Wilt.—These plants, particularly the squash, are affected very commonly with a serious bacterial wilt, causing the death of the vines. The writer has not satisfied himself that this is the same disease as the Eastern one of similar plants, caused by *Bacillus trachciphilus,* inasmuch as the symptoms of the disease are somewhat different, and cucumbers are apparently unaffected by the trouble which occurs here.

Powdery Mildew (*Erysiphe sp.*).—This is common on squash leaves but of no particular importance.

SWEET POTATO.

Wilt (*Fusarium*).—A wilting and dying of sweet potato vines, caused by a species of *Fusarium,* is the frequent cause of large losses in this crop in the Merced district. The use of new seed from outside districts has proven very satisfactory in avoiding the trouble.

TOMATO.

Wilt, Blight (*Fusarium*).—This is our most serious tomato disease. It was less abundant than usual in 1906.

Winter Blight (*Phytophthora infestans*).—This common fungus of the potato occasionally attacks winter tomatoes very seriously during the rainy season.

Fruit Rot, Blossom End Rot.—During 1906 a disease of this sort was very abundant all over the State. The cause appeared at first to be undoubtedly bacterial, but further investigation left considerable doubt as to the nature of the disease.

GRAINS AND FORAGE CROPS.

ALFALFA.

Rust (*Uromyces sp.*).—A true rust of alfalfa is considerably troublesome in the southern portions of the State during the spring season. The disease invariably disappears in the cuttings after the rains have ceased.

Leaf Spot (*Pseudopeziza medicaginis*).—This common alfalfa disease is not rare in the State, but in general can not be called a serious trouble.

GRAINS.

Smut and *rust* are extremely common and destructive in all our grains, of which wheat and barley are most important.

NUT, FOREST AND SHADE TREES.

ALMONDS. (See stone fruits.)

POPLAR.

Leaf Spot (*Marsonia populi*).—This disease, causing black spots on the leaves and twigs and defoliation of the trees, was very abundant in the State in 1906.

SYCAMORE.

Blight (*Gloesporium nervisequum*).—This disease is extremely abundant, in fact universal, on the sycamore trees of the State every spring.

WALNUT.

Bacteriosis (*Pseudomonas juglandis*).—This very serious trouble of the English walnut causes great losses in the crop every year. The disease was very abundant in 1906.

Die Back. Most of the older hard-shell orchards of southern California are dead or nearly so, and rapidly being removed on account of the dying back of the branches to the main trunk. The cause appears to lie in the occurrence of several unseasonably warm winters in recent years.

FLORAL AND ORNAMENTAL.

CHINA ASTER.

Yellows.—This physiological disease of the aster is of quite common occurrence in California.

CARNATION.

The carnation rust (*Uromyces caryophyllinus*), wilt (*Fusarium sp.*), and leaf spot (*Septoria dianthi*), all occur in California, but are not generally troublesome or destructive. The two last mentioned have been known to cause severe losses in the propagation of cuttings.

CHRYSANTHEMUM.

Rust (*Puccinia chrysanthemi*).—The chrysanthemum rust is well distributed and common over the State, yet can not be considered a serious obstacle to the growing of this plant. In the majority of cases it is only plants suffering for water or growing in very dry ground which become seriously affected.

DAHLIA.

Powdery Mildew.—A mildew is common on dahlias, but no serious injury has been observed from this source.

HOLLYHOCK.

Rust (*Puccinia malvacearum*).—The hollyhock rust is common in the State on hollyhocks and wild mallow.

OLEANDER.

Tuberculosis.—A bacterial disease similar to that of the olive, and caused by the same organism, has been found on oleanders. It is not at all general or serious.

ROSE.

Powdery Mildew (*Sphaerotheca pannosa* and *Sph. humuli*).—Two different species are found in the rose mildew so common in the State. The former of the above-named attacks the hybrid roses, Crimson Rambler, etc., producing a thick mat of felty mycelium on the shoots and twigs. In this the perithicial spore stage is found embedded. This species is very common in the State. *Sphaerotheca humuli* attacks the tea roses, producing a more delicate mycelium upon the leaves, and developing only conidial spores. This is also extremely abundant.

Rust (*Phragmidium subcorticium*).—The rose rust is very common on the hybrid roses.

Cane Blight.—A die back or blight of rose canes, caused by an apparently undescribed fungus, is abundant in California and causes serious damage.

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1902. Report of the Agricultural Experiment Station for 1898-1901.
1903. Report of the Agricultural Experiment Station for 1901-1903.
1904. Twenty-second Report of the Agricultural Experiment Station for 1903-1904.

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